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Changes in Parameters of the Elastic Element of the Composite Shaft Support

Yunusov S.Z., Makhmudova Sh.A.

Doctor of Technical Sciences, Professor, Tashkent State Transport University, Republic of Uzbekistan, Tashkent, Uzbekistan

Senior Lecturer, Branch of the Russian State University of Oil and Gas named after I.M. Gubkin in Tashkent, Republic of Uzbekistan, Tashkent, Uzbekistan

ABSTRACT: The article considers the influence of changing the parameters of the elastic element of the support of the composite shaft of the saw cylinder using the ANYSYS software, calculates and analyzes the reaction forces of the supports for different parameters of the elastic elements, and also considers the effect on the stresses of the system.

KEY WORDS: compound shaft, combined support, structural scheme, non-symmetrical arrangement of masses, saw cylinder, load, force reaction, deformation, transverse force.

I.INTRODUCTION

In world practice, special attention is paid to the development of new models of equipment and technology for ginning medium-staple varieties of raw cotton. At the same time, the implementation of targeted scientific research on the development of highly efficient designs of the working bodies of the main technological machine of the saw gin cotton mills, the creation of methods for calculating the parameters and motion modes, which allow a significant increase in the productivity of ginning.Numerous studies are devoted to the study of the technological process of ginning, the development of new working bodies, gin units, optimization of technological, kinematic, dynamic and other parameters of gins. In the Republic of Uzbekistan, large-scale measures are being taken to develop highly efficient equipment and technologies for the primary processing of raw cotton, ensuring the production of high quality products [1].

As a result of research conducted in the world on the technology and technique of ginning of raw cotton, a number of scientific results have been obtained, including:saw gins of the brand MY-171 (China), 4DP130, 5DP-130, DR-119, DPZ-180, Lummus-super 128, Herdwick-Etter with air removal of fiber, the USA and the Republic of Uzbekistan were created, calculation methods were developed massive saw cylinders (Kostroma Textile Academy, Institute of Mechanical Engineering, Russia), the laws of oscillatory movements of the working bodies of technological cotton processing machines were obtained (Ivanovo Textile Academy, Russia), the patterns of evaporation inside the material (raw cotton) during heat drying were established (Texas Tech University, USA), methods for calculating machines for the primary processing of cotton (TITLP, “Pakhtasanoat Ilmiy Markazi” JSC, Uzbekistan) [2].

Formulation of the problem. An analysis of previous research studies shows that the development of a new saw gin support design is relevant.

Development of a new design of the shaft support, which reduces the vibration of the shaft parallel to the displacement of the axis of the shaft along the vertical with an asymmetric arrangement of masses on the shaft along its length. Vibration damping of rotating shafts with

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a composite elastic element of the proposed support design, the parameters of the elastic element are selected in proportion to the distance from the point of influence of the external load to the support, the design of the composite shaft is described [3, 4].

The technological parameters of the system, acting on the shaft structure, cause internal forces (stresses) and deformations in them or qualitative changes that affect the durability. The reasons leading to such consequences are called influences [5].

When carrying out calculations of shaft structures for the effects of technological loads, it is allowed to set them as equivalent loads. Design parameters P technological loads. From the point of view of the reliability of the influence of technological loads on the reaction forces arising on the supports, deformation, they have not been sufficiently studied. Sometimes, in addition to external influences, that is, the technological loads of the system, the internal influences of the system are distinguished. Internal influences are a consequence of the interaction of the structure with the technological process, a manifestation of feedback, confirming the action of one of the basic system principles [6].

The classification of impacts is the basis for their modeling and control of the reliability of design structures, the description of which is carried out using mathematical models. Mathematical models reflect the relationship of various features and factors on which the operation of the system depends. When choosing a mathematical midsection, an analysis of the causes of stresses in the system is carried out. For the effectiveness of the analysis, we pay attention to the classification of the impact of technological loads on systems, which consists of a composite shaft with elastic elements on supports.

By origin, technological loads are divided into direct and indirect. Technological loads that have a power character are usually called direct loads. The direct load is independent of the properties or response of the structure. Indirect loads (corrosion, obsolescence, durability, elastic element parameters, etc.) affect structures through durability. Depending on the duration of action and changes over time, permanent and temporary (long-term, short-term, special) loads are distinguished [7].

Constant loads act on the structure during the entire service life without changing its value, direction and position. Permanent loads include the own weight of the structure. In addition, the forces from prestressing that remain in the structure [7].

Loads that change values or positions at different points in time are called temporary loads. Loads that act on the system, structure for a certain period of time.

We were given the task of calculating the reaction of the proposed shaft design with elastic bearing supports. The problem was solved using the ANSYS program.

II. SIGNIFICANCE OF THE SYSTEM

Analysis of structures in the ANSYS system.

Modeling an object is the main and most time-consuming stage of solving a problem. Based on mathematical models of mechanics, a geometric model of an object is specified, the types of elements used are determined, material properties and boundary conditions are specified.

1. Building a structure model (geometry, rheological properties, boundary conditions) or importing them from CAD1 systems.

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2. Studying the response of a structure to various physical influences, such as the impact of various loads, temperature and electromagnetic fields, solving problems of fluid and gas mechanics.

3. Optimization of the construction geometry.

The analysis of any task in ANSYS occurs with the help of the following steps: building a model; the solution of the problem; post-processing processing of results. You can work with the ANSYS program using both the graphical user interface - interactive mode, and using commands - command mode.

In the ANSYS system, depending on the type of solution chosen, as well as depending on the type of problem, the following parameters are determined:

- choice of method for solving the resulting systems of equations,

- setting the solution parameters (load step, number of steps, integration step, number of defined eigenforms, etc.),

- setting the accuracy of the solution,

- setting parameters for writing results to a file, etc.

To correctly specify the specification of a solution, it is necessary to know the properties of the solutions of the analyzed problems.

Construction of a calculation model for the proposed design of the saw gin composite shaft.

III. METHODOLOGY

We present the design (approximate view) of the proposed saw gin shaft with a combined support (Fig. 1.) and take the following system parameters as input:

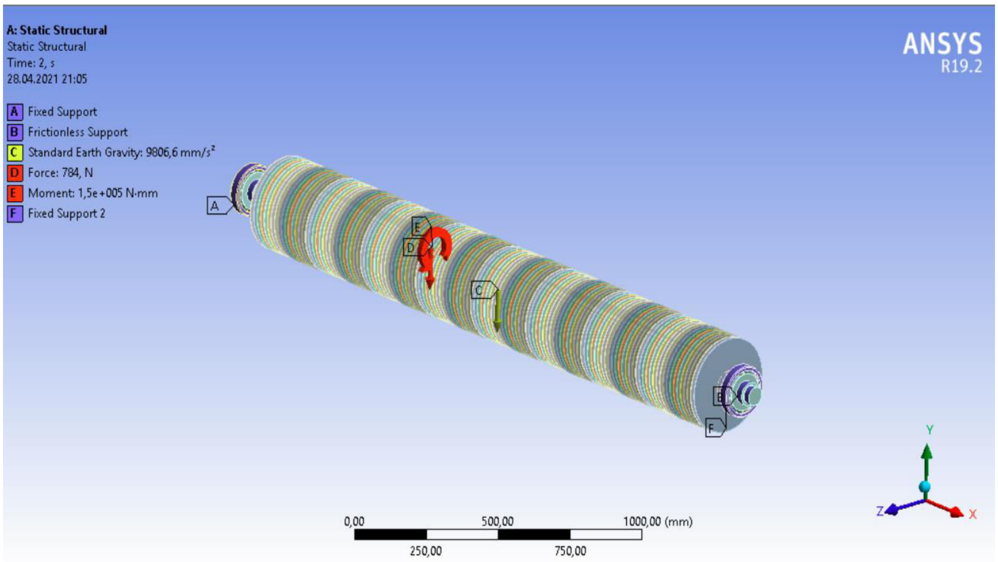

Fig.1. General view of the proposed saw gin shaft with combined

support in the ANSYS systems.

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The following system data were used in the calculations.

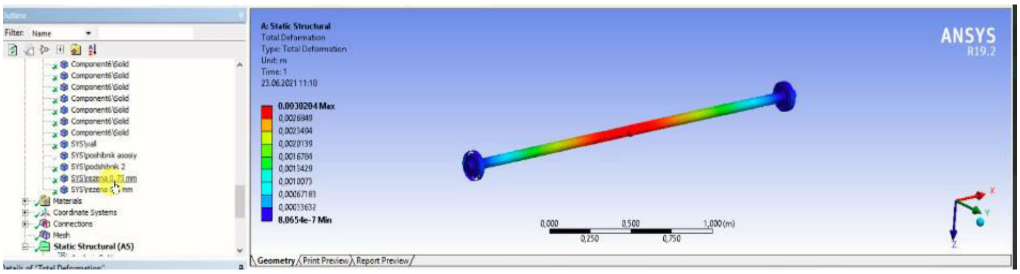
F=784N; M= 150 Nm; Fm=m1g+m2g; m1 = 141.2 kg; m2=59 kg.

Shaft: st-3, E=2 *1011; μ=0.3; ρ=7850 kg/m3.

Gasket: Aluminum 9, E=7 *1010; μ=0.34; ρ=2698 kg/m3.

Rubber: Hk 7-106, E=7 *107; μ=0.45; ρ=1200 kg/m3. L=2300mm; AD=898.95mm

We are interested in the question of how changes in the parameters of the elastic element of the support will affect the calculated loads arising in the system. In solving the mathematical model of the compound shaft of the gin saw cylinder, the geometric parameters (rubber thickness) of the elastic element changed. At the same time, two models were considered, the thickness of the elastic element in the supports varied,and the system of cumulative acting forces remained unchanged.



IV. EXPERIMENTAL RESULTS

Calculated values of a system with an elastic element of a composite shaft support. Consider the first calculation model, this is when the thickness of the elastic element on support A is greater than the thickness of the elastic element on support B. The results are summarized in Table 1. We will analyze the results of the calculation using graphs (Fig. 2.a.).

Table 1.
The thickness of the elastic element in the ratio A≥B

№	A	B	x		y		z		Total	
			R_A	R_B	R_A	R_B	R_A	R_B	R_A	R_B
1.	0	0	22,85	-22,85	1188	902	-0,38492	0,38487	1188,2	902,29
2.	0,5	0,25	8,9764	-8,9764	1147,3	943,01	-0,23695	0,23795	1167,8	943,24
3.	0,75	0,5	9,9344	-9,9344	1152,6	936,15	-0,20703	0,20703	1147,4	936,21
4.	1	0,75	10,853	-10,853	1158,1	929,84	0,089145	0,089158	1152,6	929,9
5.	1,25	1	11,795	-11,795	1163,7	923,2	0,12914	0,028714	1158,2	923,89
6.	1,5	1,25	12,751	-12,751	1170,1	917,3	0,25667	0,27567	1163,8	918,02

In the table A and B in mm, R_A and R_B in N.

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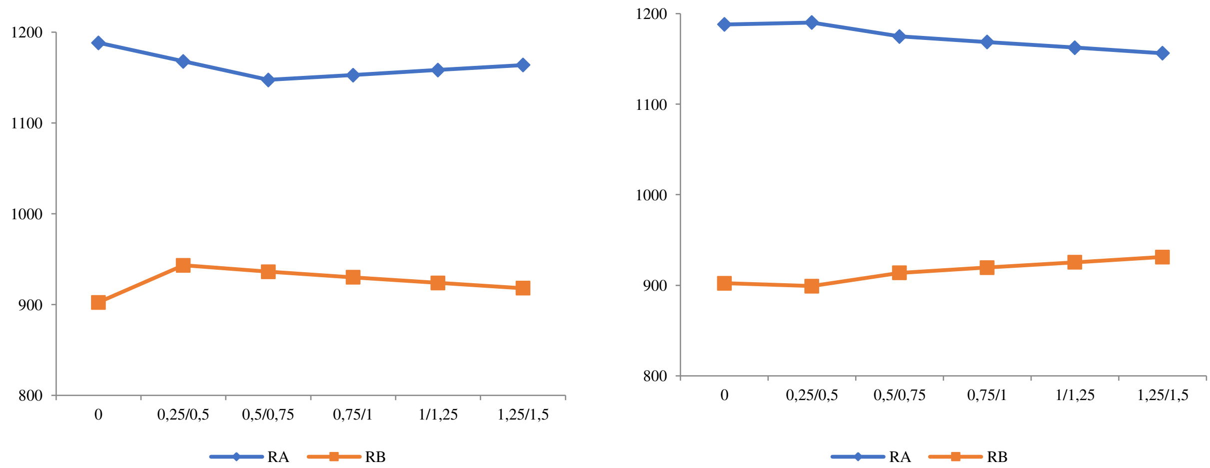
The second calculation model - we changed the value of the thickness of the elastic element on the supports proportionally, that is, the thickness of the elastic element on support B is greater than the thickness of the elastic element on support A. The results are summarizedon table 2.

We will analyze the obtained calculation results using graphs (Fig. 2.b.).

Table 2.

The thickness of the elastic element in the ratio B≥A

№	A	B	x		y		z		Total	
			R_A	R_B	R_A	R_B	R_A	R_B	R_A	R_B
1.	0	0	22,85	-22,85	1188	902	-0,38492	0,38487	1188,2	902,29
2.	0,25	0,5	3,1874	-3,1874	1190,2	899,04	-0,23881	0,23881	1190,2	899,04
3.	0,5	0,75	9,245	-9,245	1175	913,74	-0,22037	0,22037	1175	913,79
4.	0,75	1	13,373	-13,373	1168,7	919,49	-0,22879	0,22878	1168,8	919,59
5.	1	1,25	17,501	-17,501	1162,4	925,24	-0,23721	0,23719	1162,6	925,39
6.	1,25	1,5	21,629	-21,629	1156,1	930,99	-0,24563	0,2456	1156,4	931,19



a) when A≥B b) when B≥A

Fig.2. Graphic dependences of the change in reaction forces on the supports of the saw cylinder shaft on the variation in the thickness of the elastic element

We were also interested in the question of the effect of changing the parameters of the elastic element of the combined support on the stresses arising in the shaft,in particular deformation, elastic deformation and stresses of the system.

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Table 3.

The thickness of the elastic element in the ratio A≥B

№	A	B	Total Deformation - (10^(-6))			Equivalent Elastic Strain - (10^(-6))			Equivalent Stress - (10^6)		
			min	мax	average	min	мax	average	min	мax	average
1	0,5	0,25	4,65	1800	859	0,05895	963000	279000	0,000205	562	198
2	0,75	0,5	6,42	1600	802	0,0481	256000	254000	0,000973	465	166
3	1	0,75	2,18	1410	755	0,0818	158000	229000	0,000980	364	153
4	1,25	1	-0,0511	1310	707	0,0855	147000	204000	0,001053	278	139
5	1,5	1,25	-1,28	1120	651	0,09811	130000	178000	0,00109	205	112

The thickness of the elastic element in the ratio B≥A

№	A	B	Total Deformation - (10^(-6))			Equivalent Elastic Strain - (10^(-6))			Equivalent Stress - (10^6)		
			min	мax	average	min	мax	average	min	мax	average
1	0,25	0,5	3,65	1300	651	0,0115	559000	279000	0,000802	17,7	8,83
2	0,5	0,75	2,42	1400	703	0,0986	508000	254000	0,000859	105	52,3
3	0,75	1	1,18	1510	755	0,0818	458000	229000	0,000916	191	95,7
4	1	1,25	-0,0511	1610	807	0,0649	407000	204000	0,000973	278	139
5	1,25	1,5	-1,28	1720	859	0,0481	357000	178000	0,00103	365	183

In the table A and B in mm, Total Deformationin m, Equivalent Elastic Strain m/m, Equivalent Stressin Pa.

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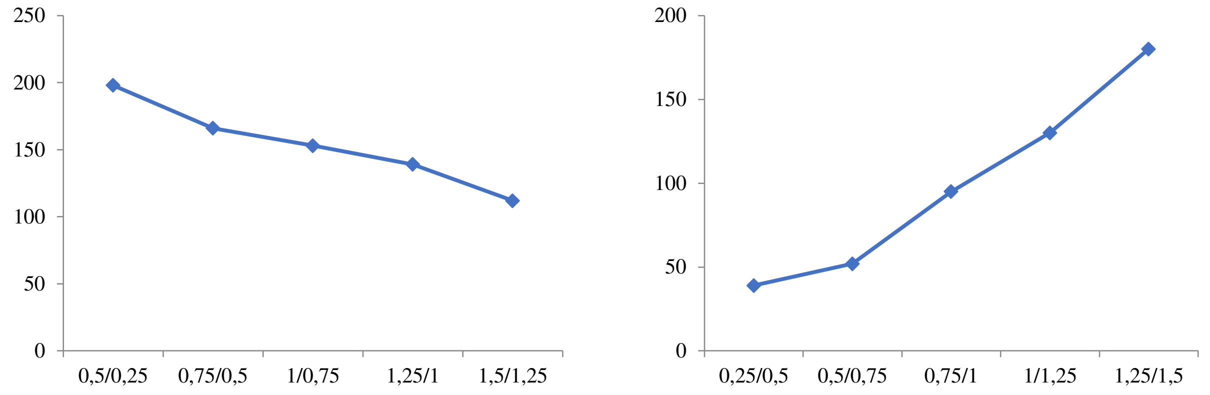
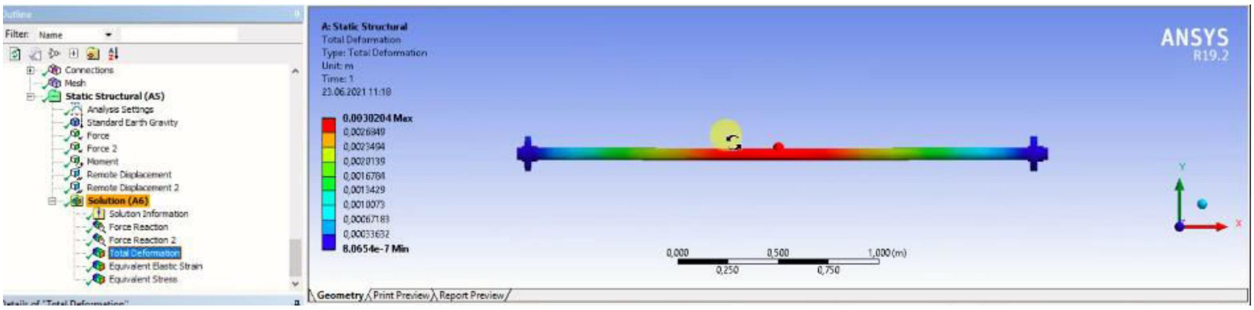


a)whenA≥B б) when B≥A

Fig.3. Graphical dependences of the system voltage change on the variation elastic element thickness



Analysis of the received data. When analyzing the results obtained, it was found that the thickness of the elastic element located on the supports also affects the stresses of the entire system. Of course, the thickness of the elastic element also affects the values of the balancing forces on the supports (reaction forces). The graphs (Fig. 2, a) show, with a greater thickness of the elastic element at point A than at point B, the magnitude of the reaction forces at the support at point B decreases R_B from 943,24 N to 918,02 N, and vice versa (Fig. 2,b) where the parameters of the elastic element at point B are greater than at point A, respectively, R_B increases from 899,04 N to 931.19 N.

These dependences, that is, the influence of the elastic element parameter on the reaction forces arising in the system, are directly proportional to the total loads of the system. From the tabular data and graphic dependencies, the following can be noted, if the thickness of the elastic element at point A is greater than at point B in Fig.3.a. system stress decreases from 198 10^6 to 112 10^6. Accordingly, if the thickness of the elastic element at point B is greater than at point A fig.3.b.system stress increases from 8,83 10^6 to 183 10^6. By changing the parameters of the elastic element, it is possible to determine the influence of the parameters of the elastic element of the composite shaft support on the resulting system stresses.

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